

Transtibial Pull-Out Repair of Converted Radial Tear Adjacent to Medial Meniscus Root



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Abstract: Radial tears increase tibiofemoral contact pressure and disrupt the ability of the meniscus to withstand hoop stress, leading to earlier-onset osteoarthritis. Repair of radial tears is problematic because they have a lower healing rate and lack a single gold standard technique. However, when a radial tear is proximal to the root, there is an opportunity to convert it into a root tear. This is ideal because root tears fixed through a transtibial tunnel technique have improved clinical outcomes and reduced rates of osteoarthritis. This Technical Note and accompanying video describe a method for repairing a radial tear near the meniscus root by converting a radial tear to a root tear followed by a pull-out root repair through a transtibial tunnel. This method restores the meniscus root, allowing it to withstand hoop stress. Our technique uses a disposable root repair kit that includes a FlipCutter, a Knee Scorpion Suture Passer, a 4.75-mm SwiveLock anchor tap, a SutureLasso, a PassPort Cannula, 0 FiberLink sutures, and TigerLink sutures.

The meniscus is composed of collagen fibers that act to distribute stresses, absorb shock, and provide joint stability for the knee.¹⁻³ The posterior root of the meniscus, which has a ligament-like structure, anchors the meniscus to the tibial plateau.⁴ Radial tears transect circumferential fibers, disrupting the ability of the meniscus to withstand hoop stress.^{2,3} Radial tears along the meniscus mid-body can be treated with a partial meniscectomy (PM) or repaired using methods like the inside-out repair, the outside-in repair, and the all-inside repair.^{2,3,5-8} However, these repairs only alleviate symptoms to varying degrees^{3,4} and are

unable to restore the meniscus to its original function.⁴ Root tears are surgically treated with a PM or reattached to the tibial plateau with a transtibial pull-out repair (TTPR) or suture anchor technique.^{4,9-11}

A radial tear of the posterior root is defined as a tear within 10 mm of the posterior tibial attachment of the medial meniscus.¹² These tears can weaken tensile strength, cause meniscal extrusion, and lead to abnormal biomechanics.¹³ The purpose of this Technical Note and accompanying video is to convey a technique that repairs a radial tear adjacent to the medial meniscus posterior root (MMPR) by converting the radial tear to a root tear then performing a transtibial pull-out root repair using an efficient, easily replicable method with a disposable repair kit.

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Surgical Technique

Preoperative Assessment

Magnetic resonance imaging of the knee joint (sagittal and coronal, posterior) demonstrates a radial tear at the posterior horn-body junction of the medial meniscus (Figs 1 and 2).

Patient Positioning

After general anesthesia is induced, the patient is positioned supine on the operating table with a Mizuho OSI Leg Holder (Mizuho OSI, Union City, CA). The head and body prominences are well-cushioned. Non-sterile Webril padding and a tourniquet are applied to



Fig 1. Magnetic resonance imaging of the right knee, sagittal view. Increased signaling can be seen in the posterior horn of the medial meniscus (arrow).

the thigh. The lower extremity is prepped and draped in the usual sterile fashion (Fig 3).

Arthroscopic Portal Placement (With Video Illustration)

Anatomic landmarks on the knee are identified and marked. A standard anterolateral portal is made and diagnostic arthroscopy is performed (Video 1). The radial tear of the medial meniscus near the root–body junction is visualized with diagnostic arthroscopy. An



Fig 2. Magnetic resonance imaging of the right knee, coronal view, posterior. Signaling caused by the radial tear adjacent to the medial meniscus root seen (arrow).



Fig 3. The patient was positioned supine on the operating table with the right leg in a Mizuho OSI Leg Holder. The head and bony prominences were well-padded.

anteromedial portal is created and a probe is introduced to determine the extent of the tear.

Conversion of the Radial Tear and Repair Through a Transtibial Tunnel

A nonaggressive shaver and a meniscal biter are used to remove the root stump. Next, the mobility of the medial meniscus is tested to determine whether it is a suitable candidate for a root repair. A clamp is used to insert a PassPort (Arthrex, Naples, FL) cannula into the anteromedial portal. The tip of the Knee Scorpion Suture Passer (Arthrex) (Fig 4) is passed through the looped end of the 0 FiberLink suture (Fig 5). The tail of the FiberLink suture is loaded onto the Scorpion Suture Passer. The suture is passed through the meniscal tissue just medial to the root tear (Figs 6 and 7). The free end of the suture is pulled to secure a cinch suture in the medial meniscus (Fig 8). If desired, another suture may be passed through the meniscus.

Subsequently, an aiming guide (Fig 4) is used to site the tibial tunnel. A 1-cm incision over the anterior tibia is created with a #15 blade and dilated with a clamp (Fig 9). The FlipCutter (Arthrex) (Fig 5) is used to drill through the guide until the tip of the FlipCutter emerges at the root origin on the tibial plateau (Fig 10). The aiming guide is then removed and the FlipCutter is flipped, backreamed approximately 5 mm, straightened, and removed. A SutureLasso (Arthrex) is passed through the tibial tunnel and a grasper is used to pass the FiberLink suture through the loop. Using the SutureLasso, the FiberLink suture is pulled through the



Fig 4. Knee Scorpion Suture Passer (right) used to pass suture through the meniscus. The ACL Guide Frame Handle Assembly (left) is used as a guide to drill through the tibia.

tibial tunnel (Fig 11). The suture is loaded onto a 4.75-mm SwiveLock (Arthrex) (Fig 5). A pilot hole is drilled in the anterior tibia and prepared with a 4.75-mm SwiveLock anchor tap (Arthrex) (Fig 5). Tension is applied to the suture, and the anchor is screwed into the tibial hole receiving appropriate bony purchase until the anchor is flush with the cortex (Fig 12).

Postoperative Care

The patient is encouraged to wear a brace at all times for the first 2 weeks and is nonweight-bearing for the first 4 weeks. Physiotherapy begins after the first

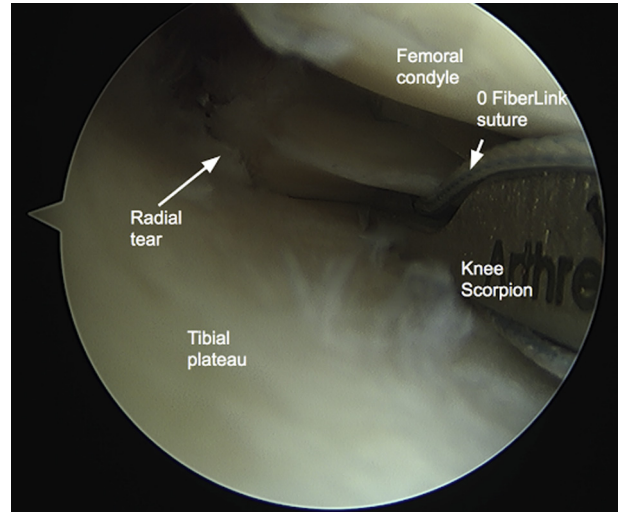


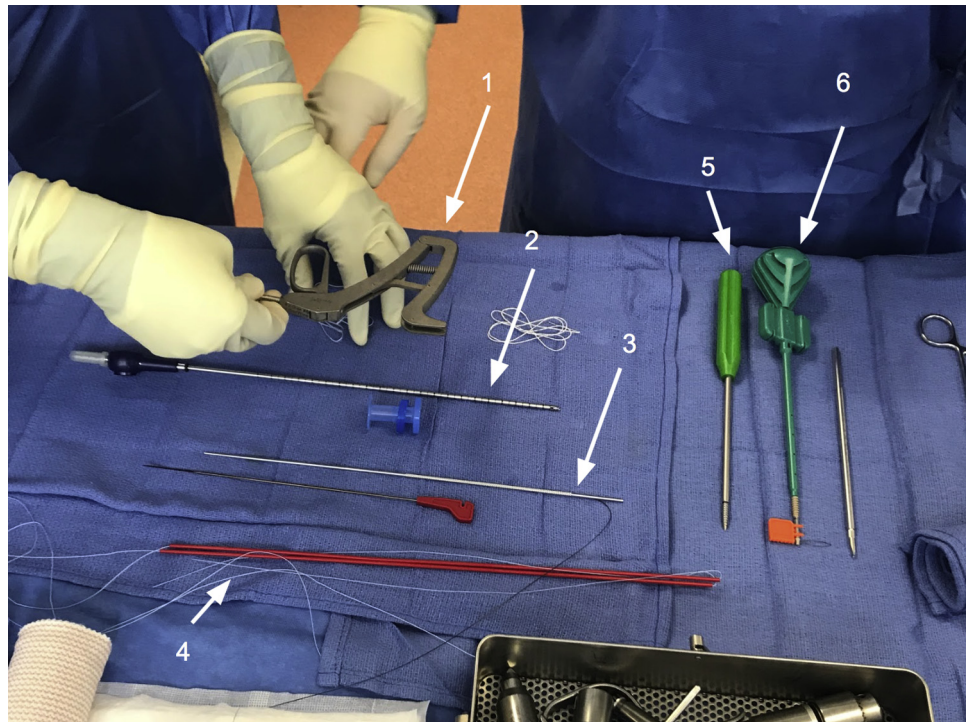
Fig 6. Arthroscopic view from the anterolateral portal of the right knee shows the Knee Scorpion taking a bite of the medial meniscal tissue just medial to the root tear. Radial tear of the medial meniscus posterior root in the upper right-hand corner is visible. The Knee Scorpion is loaded with a 0 FiberLink suture and is passed through the anterolateral portal.

postoperative visit. The patient may return to squatting and deep flexion after 6 months.

Discussion

Untreated radial tears adjacent to MMPRs cause meniscal extrusion, disrupt joint loading, induce a state

Fig 5. Disposable root repair kit that contains (1) Knee Scorpion Suture Passer to pass suture; (2) FlipCutter to drill the tibial tunnel; (3) guidewire to guide suture passing; (4) 0 FiberLink Suture, which is used to make the cinch suture through the meniscus; (5) Push/Tap for 4.75-mm SwiveLock used to secure suture anchor to the tibia; and (6) 4.75-mm SwiveLock to load suture anchor.



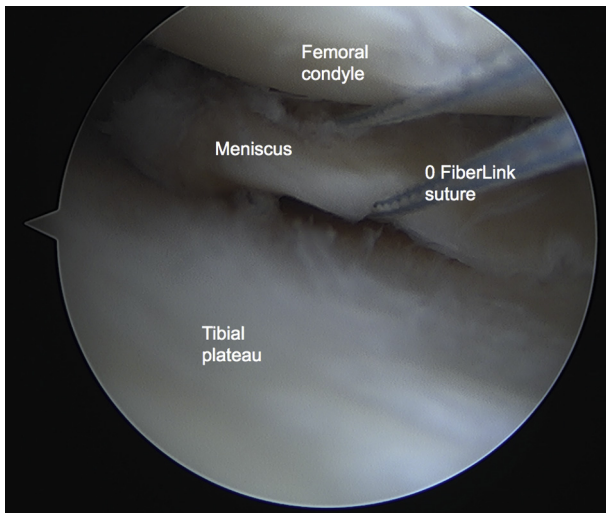


Fig 7. Arthroscopic view from the anterolateral portal of the right knee shows the 0 FiberLink suture passed through the medial meniscus.

similar to that of a total meniscectomy, and can lead to degenerative arthritis.¹³⁻¹⁵ Some arthroscopic and biomechanical studies suggest that the incidence of radial meniscus tears found at or near the attachment site ranges between 10% and 28% of all meniscal tears.^{13,16-18} Many studies describe methods to repair radial tears of the midbody of the meniscus and posterior root tears.^{2,4-7,10,11} However, the literature lacks methods to repair a radial tear neighboring a posterior root. In past surgical studies, these radial tears were solely treated with a PM, which caused the development of medial compartment arthritis.¹⁵⁻¹⁷ In contrast, root repairs delay the progression of arthritis in most cases.^{8,19-21} This Technical Note presents a

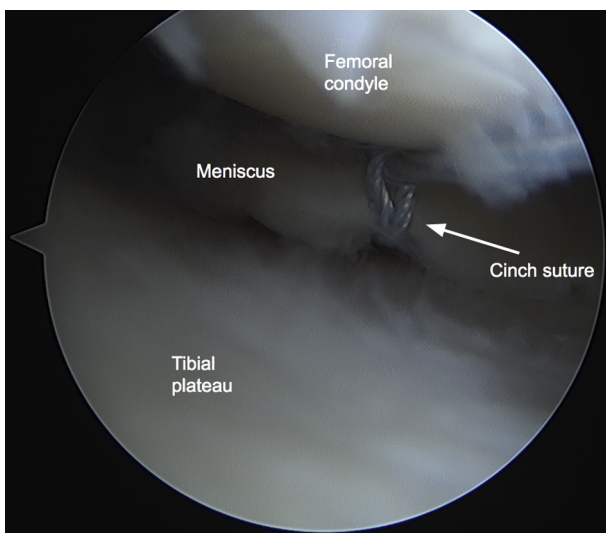


Fig 8. Arthroscopic view from the anterolateral portal of the right knee shows the cinch suture stitched through the medial meniscus.

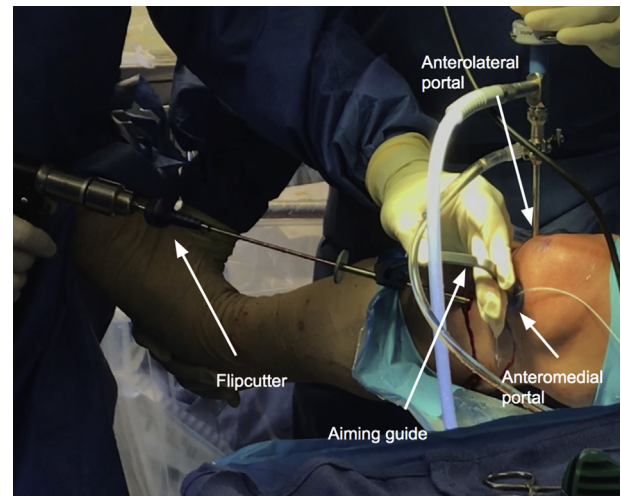


Fig 9. The aiming guide is used to align the FlipCutter to correctly drill through the tibia of the right knee. The aiming guide is placed in the anteromedial portal and the arthroscope is placed in the anterolateral portal.

procedure for relieving symptoms of radial tears adjacent to the posterior root while maintaining meniscal integrity.

Our repair method involves converting the radial tear to a root tear. The root is then refixed to the meniscus using a pull-out repair through a transtibial tunnel. In 2015, Chung et al.⁹ found in a 5-year minimum follow-up that while PM of MMPR tears often lead to degenerative arthritis, refixation is effective in restoring hoop tension. Feucht et al.¹⁹ examined clinical, radiographic, and second-look arthroscopic results of 172 patients between 11 and 40 months' status post for a TTPR. They reported that this repair significantly improves functional and clinical outcomes and stops the progression of osteoarthritis in 82% of patients.¹⁹

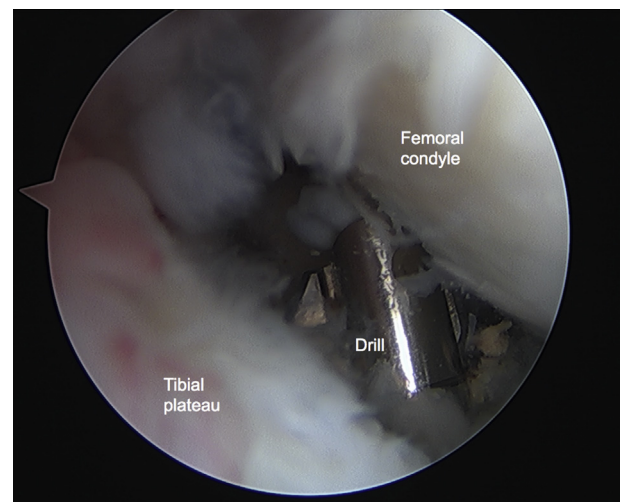


Fig 10. Arthroscopic view from the anterolateral portal of the right knee shows the tip of the drill through the tibia to create the transtibial portal.

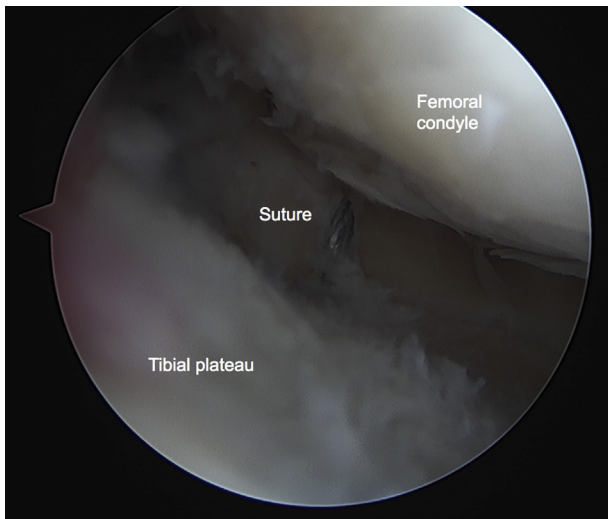


Fig 11. Arthroscopic view from the anterolateral portal of the right knee shows finished cinch suture pulled through the tibial tunnel. The area has been debrided. When cinched down and tied, the suture repairs the radial tear of the medial meniscus posterior root and the flap created by the tear is securely attached to the tibial plateau.

There are minimal studies examining the effectiveness of a TTPR to repair a radial tear adjacent to a MMPR. Padalecki¹⁵ performed a biomechanical study to understand the consequences of complete radial tears of the MMPR and research different repair outcomes and found that a TTPR restored contact area and pressure to a state statistically indistinguishable to those of an intact meniscus.¹⁵ In 2018, Chung et al.²² found that a TTPR improved peak contact pressure and contact surface area significantly.



Fig 12. Push/Tap for 4.75-mm SwiveLock used to secure the suture anchor to the tibia of the right knee after suture has been pulled through the transtibial tunnel.

Table 1. Advantages and Disadvantages of the Pullout Suture Through a Transtibial Tunnel Using a Suture Anchor

Advantages	Disadvantages
Technically easier than a suture anchor technique	Possible risk of neurovascular injury if transtibial tunnel drilled incorrectly
Root repairs have greater healing rates than repair of radial tears	In some cases, less effective at restoring contact area than suture anchor technique
Soft tissue of the knee joint will not interfere with anchor bone fixation	Transtibial tunnel can interfere with concomitant procedures
Standard arthroscopic portals used	There is a possibility of suture elongation and abrasion through bone tunnel
Only one stitch required, but additional sutures may be added	
Suture anchor is knotless and provides strong attachment to the tibia	

Our technique maintains the benefits provided by a standard TTPR while repairing a radial tear, which normally has a low healing rate. The devices used, including the FlipCutter, Knee Scorpion, SutureLasso, PassPort cannula, and SwiveLock anchor, were conveniently located in the same disposable root repair kit, maximizing efficiency during operation. The FiberLink suture was preloaded onto the Knee Scorpion Suture Passer, facilitating easy creation of the racking hitch knot, which minimized iatrogenic damage and reduced operative time. Furthermore, the FlipCutter can ream in a retrograde fashion, eliminating issues caused by the creation of the femoral canal through the anteromedial portal.²³ In addition, a suture anchor was used instead of a button (4.75-mm PushLock; Arthrex) to secure the repair suture to the anterior tibial cortex.

There are some potential limitations of the TTPR (Tables 1 and 2). A comparison study of 51 consecutive patients undergoing a suture anchor or TTPR found similar clinical improvements in both, but findings on magnetic resonance imaging reported a greater degree of complete healing after the suture anchor repair.²⁴ Seo et al.²⁵ tested 11 porcine knees and found that

Table 2. Pearls and Pitfalls of the Pullout Suture Through a Transtibial Tunnel Using a Suture Anchor

Pearls	Pitfalls
Backreaming using FlipCutter avoids using anteromedial portal	Failure to attach the meniscus to the anatomical position can lead to altered biomechanics
FiberLink suture was preloaded onto Knee Scorpion Suture Passer, which facilitated an easier creation of the racking hitch knot	Detensioning of sutures during debridement can lead to inadvertent cutting of sutures
	Improper guide placement may result in multiple tibial drill attempts

although a TTPR of a radial tear of the MMPR significantly reduced tibiofemoral peak contact pressure between 30 and 90°, it failed to do so at 0 to 15° of flexion.²⁵ Moreover, after the TTPR, the pivot site during meniscal movement moves to the pull-out suture site, altering normal joint mechanics.¹² In addition, sutures through a transtibial tunnel are susceptible to elongation and abrasion.¹⁰ The tibial tunnel also can obstruct concomitant ligament reconstruction procedures.¹⁰ Further studies are necessary to analyze whether this technique leads to better patient outcomes and lower failure rates.

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